CLAIMS

What is claimed is:

1. A solid cage for containing a stack of fuel cells, comprising

(A) a top end plate;

(B) a bottom end plate;

(C) at least two struts, each strut attached to the bottom end plate and the top end plate so as to fix the top and bottom end plates in a spaced-apart relationship, wherein the fuel cell stack can be disposed between the top and the bottom end plates, and between the struts;

(D) a pressure plate disposed between the fuel cell stack and the top end plate; and

(E) means for effecting a downward displacement of the pressure plate relative to the bottom end plate;

wherein, a compressive force to the fuel cell stack may be applied by downwardly displacing the pressure plate relative to the bottom end plate so as to apply a compressive force to the fuel cell stack as between the pressure plate and the bottom end plate.

2. The cage of claim 1, wherein the means for effecting a downward displacement of the pressure plate comprises an array of horizontally-spaced adjustable spacers collectively located between and acting as an array of spacers between the top end plate and the pressure plate, each spacer being vertically adjustable so as to vary the distance between the pressure plate and the top end plate in the vicinity of such spacer.

3. The cage of claim 2, wherein the adjustable spacers are jack

screws, and wherein the top end plate has an array of threaded jack-screw holes, through which the jack screws are threaded so as to downwardly displace the pressure plate.

4. The cage of claim 3, wherein vertically-compressible springs are disposed between the jack screws and the pressure plate.

5. The cage of claim 4, wherein the springs are dish springs.

6. The cage of claim 1, wherein the means for effecting a downward displacement of the pressure plate comprises an expansion structure interposed between the top end plate and the pressure plate.

7. The cage of claim 1, wherein the struts are four in number, the attachment of each strut to the bottom end plate and top end plate being proximate to a discrete associated corner of the bottom end plate and top end plate, such that each strut is proximate to a vertical edge corner of the fuel cell stack.

8. The cage of claim 6, wherein the struts are L-shaped in horizontal cross-section so as to form vertically-extending inside corners, and the struts are attached to the bottom end plate and the top end plate such that the inside corners face the fuel cell stack and engage the vertical edge corners of the fuel cell stack, so as to prevent horizontal displacement of the fuel cell stack relative to the cage.

9. The cage of claim 7, further comprising electrically-non-conductive strut liners disposed between the struts and the fuel cell stack so as to electrically insulate the struts from the fuel cell stack.

10. The cage of claim 8, wherein the strut liners are sized and shaped to seal the space between the struts and the fuel cell stack so as to impede the passage of fluid therebetween.

11. The cage of claim 6, wherein the attachment between each strut and an end plate comprises:

(A) an attachment bolt;

(B) a vertically-extending hole in the end plate through which the attachment bolt can be inserted; and

(C) a vertically-extending threaded socket in the end of the strut, into which the attachment bolt can be screwed;

wherein the strut may be removably attached to the end plate by inserting the attachment bolt through the end plate and screwing it into the threaded socket.

12. The cage of claim 6, wherein the attachment between each strut and an end plate comprises:

(A) an attachment bolt;

(B) a horizontally-extending foot fixed to the end of the strut and having a vertically-extending hole through which the attachment bolt can be inserted; and

(C) a vertically-extending threaded receptacle in the end plate, into which the attachment bolt can be screwed;

wherein the strut is attached to the end plate by inserting the attachment bolt through the hole in the foot and screwing it into the threaded receptacle.

13. The cage of claim 11, wherein the foot and receptacle each have a vertically-extending internal-manifold opening, aligned one with the other for communicating with an internal manifold in the stack of fuel cells.

14. A fuel cell stack comprising:

(A) a pair of internal manifolds for providing fuel to, and exhausting fuel from, the fuel cell stack;

(B) at least one opening on a first side of the fuel cell stack for providing oxidant to the fuel cell stack;

(C) at least one opening on a second side of the fuel cell stack for exhausting oxidant from the fuel cell stack;

(D) at least one opening on a third side of the fuel cell stack for providing cooling fluid to the fuel cell stack; and

(E) at least one opening on a fourth side of the fuel cell stack for exhausting cooling fluid from the fuel cell stack.

15. The fuel cell stack of claim 14 wherein the first and second sides of the fuel cell stack are opposite each other and the third and fourth sides of the fuel cell stack are opposite each other such that the general direction of flow of the oxidant is substantially perpendicular to the general direction of flow of the cooling fluid.

16. The fuel cell stack of claim 15 wherein the third and fourth sides are wider than the first and second sides.

17. The fuel cell stack of claim 16 further comprising:

(A) oxidant-gas channels, each opening to the first and second sides, and through which the oxidant passes when flowing from the first side to the second side; and

(B) cooling fluid passages, each opening to the third and fourth sides, and through which the cooling fluid passes when flowing from the third side to the fourth side.

18. A solid cage for containing a fuel cell stack, comprising

(A) a top end plate;

(B) a bottom end plate; and

(C) four struts, each strut attached to the bottom end plate and the top end plate, and each strut is L-shaped in cross-section so as to form vertically-extending inside corners;

wherein, the inside corners of the struts mate with and are engageable with a vertical edge corner of the fuel cell stack, so as to prevent horizontal displacement of the fuel cell stack components relative to the cage.

19. The cage of claim 18, further comprising electrically-non-conductive strut liners disposed between the struts and the fuel cell stack so as to electrically insulate the struts from the fuel cell stack.

20. The cage of claim 19, wherein the strut liners are sized and shaped to seal the space between the struts and the fuel cell stack so as to impede the passage of fluid therebetween.

21. The cage of claim 18, wherein the attachment between each strut and an end plate comprises:

(A) an attachment bolt;

(B) a vertically-extending hole in the end plate through which the attachment bolt can be inserted; and

(C) a vertically-extending threaded socket at the end of the strut, into which the attachment bolt can be screwed;

wherein the strut is attached to the end plate by inserting the

attachment bolt through the end plate and screwing it into the threaded socket.

22. The cage of claim 18, wherein the attachment between each strut and an end plate comprises:

(A) an attachment bolt;

(B) a horizontally-extending foot fixed to the end of the strut and having a vertically-extending hole through which the attachment bolt can be inserted; and

(C) a vertically-extending threaded receptacle in the end plate, into which the attachment bolt can be screwed;

wherein the strut is attached to the end plate by inserting the attachment bolt through the hole in the foot and screwing it into the threaded receptacle.

23. The cage of claim 22, wherein the foot and receptacle each have a vertically-extending internal-manifold opening, aligned one with the other.

24. A solid cage fuel cell stack comprising:

(A) a rectangular-parallelepiped stack of fuel cells, having:

(i) a pair of internal manifolds for providing fuel to, and exhausting fuel from, the fuel cell stack;

(ii) at least one opening on a first side of the fuel cell stack for providing oxidant to the fuel cell stack;

(iii)at least one opening on a second side of the fuel cell stack for exhausting oxidant from the fuel cell stack;

(iv) at least one opening on a third side of the fuel cell stack for providing cooling fluid to the fuel cell stack; and

(v) at least one opening on a fourth side of the fuel cell stack for exhausting cooling fluid from the fuel cell stack; and

(B) a cage containing the fuel cell stack and having:

(i) a top end plate

(ii) a bottom end plate;

(iii)means for fixing the top and bottom end plates in a spaced-apart relationship, said fixing means having vertically-extending inside corners that mate with and engage vertical edge corners of the fuel cell stack, wherein the fuel cell stack is disposed between the top and the bottom end plates, and between the fixing means;

(iv) a pressure plate disposed between the fuel cell stack and the top end plate; and

(v) means for effecting a downward displacement of the pressure plate relative to the bottom end plate;

wherein, a compressive force to the fuel cell stack may be applied by downwardly displacing the pressure plate relative to the bottom end plate so as to apply a compressive force to the fuel cell stack as between the pressure plate and the bottom end plate.

25. The solid cage fuel cell stack of claim 24 wherein the first and second sides of the fuel cell stack are opposite each other and the third and fourth sides of the fuel cell stack are opposite each other such that the general direction of flow of

the oxidant is substantially perpendicular to the general direction of flow of the cooling fluid.

26. The solid cage fuel cell stack of claim 25 wherein the third and fourth sides are wider than the first and second sides.

27. The fuel cell stack of claim 26 further comprising:

(A) oxidant-gas channels, each opening to the first and second sides, and through which the oxidant passes when flowing from the first side to the second side; and

(B) cooling fluid passages, each opening to the third and fourth sides, and through which the cooling fluid passes when flowing from the third side to the fourth side.

28. The solid cage fuel cell stack of claim 22 wherein the means for fixing the top and bottom end plates in a spaced-apart relationship comprises at least two struts, each strut attached to the bottom end plate and the top end plate.

29. The cage of claim 28, wherein the struts are four in number, the attachment of each strut to the bottom end plate and top end plate being proximate to a discrete associated corner of the bottom end plate and top end plate, such that each strut is proximate to a vertical edge corner of the fuel cell stack.

30. The cage of claim 29, further comprising electrically-non-conductive strut liners disposed between the struts and the fuel cell stack so as to electrically insulate the struts from the fuel cell stack.

31. The cage of claim 30, wherein the strut liners are sized and shaped to seal the space between the struts and the fuel cell stack so as to impede the passage of fluid therebetween.

32. The cage of claim 28, wherein the attachment between a strut

and an end plate comprises:

(A) an attachment bolt;

(B) a vertically-extending hole in the end plate through which the attachment bolt can be inserted; and

(C) a vertically-extending threaded socket in the end of the strut, into which the attachment bolt can be screwed;

wherein the strut may be removably attached to the end plate by inserting the attachment bolt through the end plate and screwing it into the threaded socket.

33. The cage of claim 28, wherein the attachment between a strut and an end plate comprises:

(A) an attachment bolt;

(B) a horizontally-extending foot fixed to the end of the strut and having a vertically-extending hole through which the attachment bolt can be inserted; and

(C) a vertically-extending threaded receptacle in the end plate, into which the attachment bolt can be screwed;

wherein the strut is attached to the end plate by inserting the attachment bolt through the hole in the foot and screwing it into the threaded receptacle.

34. The cage of claim 33, wherein the foot and receptacle each have a vertically-extending internal-manifold opening, aligned one with the other for communicating with an internal manifold in the stack of fuel cells.

35. The cage of claim 24, wherein the means for effecting a downward displacement of the pressure plate comprises an array

of horizontally-spaced adjustable spacers collectively located between and acting as an array of spacers between the top end plate and the pressure plate, each spacer being vertically adjustable so as to vary the distance between the pressure plate and the top end plate in the vicinity of such spacer.

36. The cage of claim 35, wherein the adjustable spacers are jack screws, and wherein the top end plate has an array of threaded jack-screw holes, through which the jack screws are threaded so as to downwardly displace the pressure plate.

37. The cage of claim 36, wherein vertically-compressible springs are disposed between the jack screws and the pressure plate.

38. The cage of claim 37, wherein the springs are dish springs.

39. The cage of claim 24, wherein the means for effecting a downward displacement of the pressure plate comprises an expansion structure interposed between the top end plate and the pressure plate.